PUBLIC NOTICE

Federal Communications Commission
445 12th St., S.W.
Washington, D.C. 20554

News Media Information 202 / 418-0500
Internet: http://www.fcc.gov
TTY: 1-888-835-5322

DA 02-2138
August 30, 2002

Measurement Procedure Updated for Peak Transmit Power in the Unlicensed National Information Infrastructure (U-NII) Bands

This notice announces an update to the measurement procedures for U-NII devices that are used to determine compliance with the FCC's technical rules. These changes will better accommodate recent developments in U-NII transmission technologies.

The current U-NII rules define "Peak Transmit Power" as "the maximum transmit power as measured over an interval of time of at most 30/B seconds or the transmission pulse duration of the device, whichever is less, under all conditions of modulation", where B is the 26-dB emission bandwidth of the signal. The rules were intended to permit averaging of peak transmit power over multiple symbols. However, for new multi-carrier technologies, a 30/B averaging interval may not be sufficient for averaging across multiple symbols. For example, an IEEE 802.11(a) signal has a symbol duration of four microseconds, but can have an emission bandwidth of 35 MHz, leading to an upper limit on averaging time of 30/B = 0.86 microseconds. Hence, averaging is performed over less than a single symbol.

To accommodate this new technology peak transmit power may be averaged across symbols over an interval of time equal to the transmission pulse duration of the device or over successive pulses. The averaging must include only time intervals during which the transmitter is operating at its maximum power level and must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level.

Appendix A describes acceptable measurement procedures under this interpretation. Though not required, provision of a continuous transmit mode on devices to be tested will simplify the measurement process. Where possible, averaging may be performed by trace averaging. When signal characteristics (short pulse widths and wide emission bandwidths) preclude the use of trace averaging, averaging may be implemented by means of a "video filter" in the spectrum analyzer, as described in the appendix. The appendix also includes procedures for measurement of emission bandwidth, peak power spectral density, and peak excursion of the modulation envelope.

Questions pertaining to this document may be directed to Steve Martin at (301) 362-3052 or via email at smartin@fcc.gov.

APPENDIX A

Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E

AUGUST 2002

This document provides guidance for determining compliance of U-NII devices under Part 15, Subpart E. It includes:

- **Acceptable procedures for measuring peak conducted transmit power, peak power spectral density, emission bandwidth, and peak excursion measurement.**

All operating modes or data rates of a device must satisfy the requirements.

ACCEPTABLE PROCEDURES:

Peak conducted transmit output power.

In the following, "T" is the transmission pulse duration over which the transmitter is on and transmitting at its maximum power control level.
Measurements are performed with a spectrum analyzer. Three methods are provided to accommodate measurement limitations of the spectrum analyzer depending on signal parameters. Set resolution bandwidth (RBW) = 1 MHz. Set span to encompass the entire emission bandwidth (EBW) of the signal. Use automatic setting for analyzer sweep time (except in Method #2). Check the sweep time to determine which procedure to use.

- If sweep time ≤ T, use Method #1 -- spectral trace averaging -- and sum the power across the band. Note that the hardware operation may be modified to extend the transmission time to achieve this condition for test purposes. (Method #1 may be used only if it results in averaging over intervals during which the transmitter is operating at its maximum power control level; intervals during which the transmitter is off or is transmitting at a reduced power level must not be included in the average.)
- If sweep time > T, then the choice of measurement procedure will depend on the EBW of the signal.
  - ◊ If EBW ≤ largest available RBW on the analyzer, use Method #2--zero-span mode with trace averaging--and find the temporal peak. (Method #2 may be used only if it results in averaging over intervals during which the transmitter is operating at its maximum power control level; intervals during which the transmitter is off or is

transmitting at a reduced power level must not be included in the average.)

- ◊ If EBW > largest available RBW, use Method #3--video averaging with max hold--and sum power across the band.

Method #1:

- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 1 MHz.
- Set VBW ≥ 3 MHz.
- Use sample detector mode if bin width (i.e., span/number of points in spectrum display) < 0.5 RBW. Otherwise use peak detector mode
- Use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at full control power for entire sweep of every sweep. If the device transmits continuously, with no off intervals or reduced power intervals, the trigger may be set to “free run”.
- Trace average 100 traces in power averaging mode.
- Compute power by integrating the spectrum across the 26 dB EBW of the signal. The integration can be performed using the spectrum analyzer’s band power measurement function with band limits set equal to the EBW band edges or by summing power levels in each 1 MHz band in linear power terms. The 1 MHz band power levels to be summed can be obtained by averaging, in linear power terms, power levels in each frequency bin across the 1 MHz.

Method #2:

- Set zero span mode. Set center frequency to the midpoint between the -26 dB points of the signal.
- Set RBW ≥ EBW.
- Set VBW ≥ 3 RBW. [If VBW ≥ 3 RBW is not available, use highest available VBW, but VBW must be ≥ RBW]
- Set sweep time = T
- Use sample detector mode.
- Use a video trigger with the trigger level set to enable triggering only on full power pulses.
- Trace average 100 traces in power averaging mode.
- Find the peak of the resulting average trace.

Method #3:

- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set sweep trigger to “free run”.
- Set RBW = 1 MHz. Set VBW ≥ 1/T
- Use linear display mode.

- Use sample detector mode if bin width (i.e., span/number of points in spectrum) < 0.5 RBW. Otherwise use peak detector mode.
- Set max hold.
- Allow max hold to run for 60 seconds.
- Compute power by integrating the spectrum across the 26 dB EBW or apply a bandwidth correction factor of 10 log(EBW/1 MHz) to the spectral peak of the emission. The integration can be performed using the spectrum analyzer's band power measurement function with band limits set equal to the EBW band edges or by summing power levels in each 1 MHz band in linear power terms. The 1 MHz band power levels to be summed can be obtained by averaging, in linear power terms, power levels in each frequency bin across the 1 MHz.

Emission bandwidth "B" MHz.

- Use a RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW
- Use a peak detector.
- Do not use the Max Hold function. Rather, use the view button to capture the emission.
- Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Peak power spectral density(PPSD).

This is an antenna conducted measurement using a spectrum analyzer. Method #2 provides the most accurate implementation of the rule; however, equipment limitations may preclude its use for short pulses. Method #1 is also acceptable to show compliance; it may overestimate the PPSD, but is easier to implement than method #2, and must be used when the conditions of method #2 cannot be achieved.

Method 1:

Use peak detector mode and max hold. Set RBW= 1MHz* and VBW > 1 MHz. The PPSD is the highest level found across the emission in any 1-MHz band.

Method 2:

Use sample detector and power averaging (not video averaging) mode. Set RBW= 1 MHz*, VBW > 1 MHz. The PPSD is the highest level found across the emission in any 1-MHz band after 100 sweeps of averaging. This method is permitted only if the transmission pulse or sequence of

pulses remains at maximum transmit power throughout each of the 100 sweeps of averaging and that the interval between pulses is not included in any of the sweeps (e.g., 100 sweeps should occur during one transmission, or each sweep gated to occur during a transmission).

* When the emission bandwidth is less than 1 MHz, use a measurement bandwidth equal to the emission bandwidth, in accordance with Section 15.407(a)5.
* It is permissible to use a resolution bandwidth less than the measurement bandwidth provided the measured power is integrated to show total power over the measurement bandwidth. The integration can be performed using the spectrum analyzer's band power measurement function with band limits set equal to the measurement band edges or by summing power levels in each band in linear power terms.

Peak excursion measurement.

Set the spectrum analyzer span to view the entire emission bandwidth. The largest difference between the following two traces must be ≤ 13 dB for all frequencies across the emission bandwidth. Submit a plot.

1st Trace:

- Set RBW = 1 MHz, VBW ≥ 3 MHz with peak detector and max-hold settings.

2nd Trace:

- If Method #1 was used for the peak conducted transmit output power test, then create the 2nd trace using the settings described in Method #1.

- If Methods #2 or #3 were used for the peak conducted transmit power test, then create the 2nd trace using the setting described in Method #3.